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WIPP Disposal Room Closure Calculations for Various Waste Inventories

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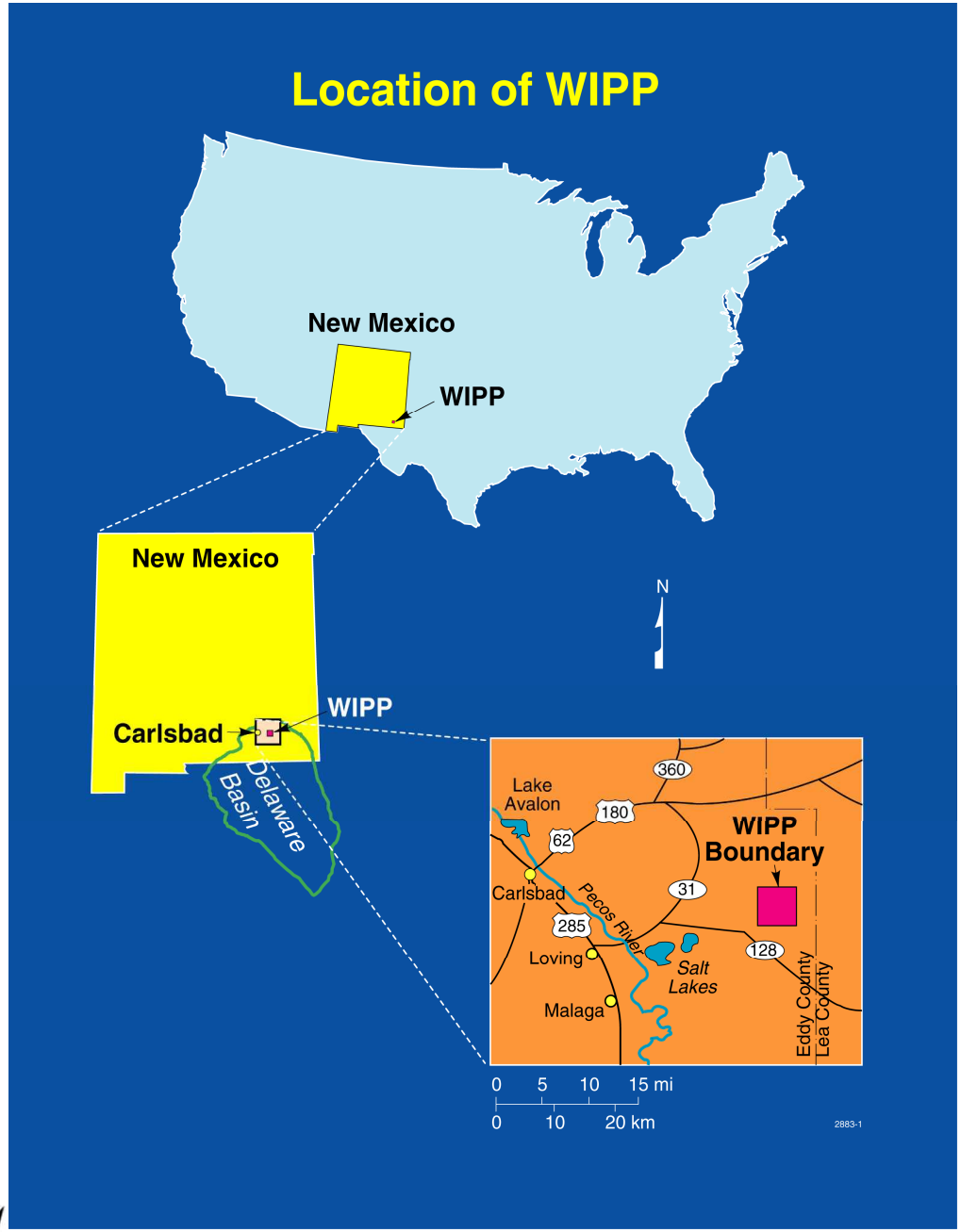
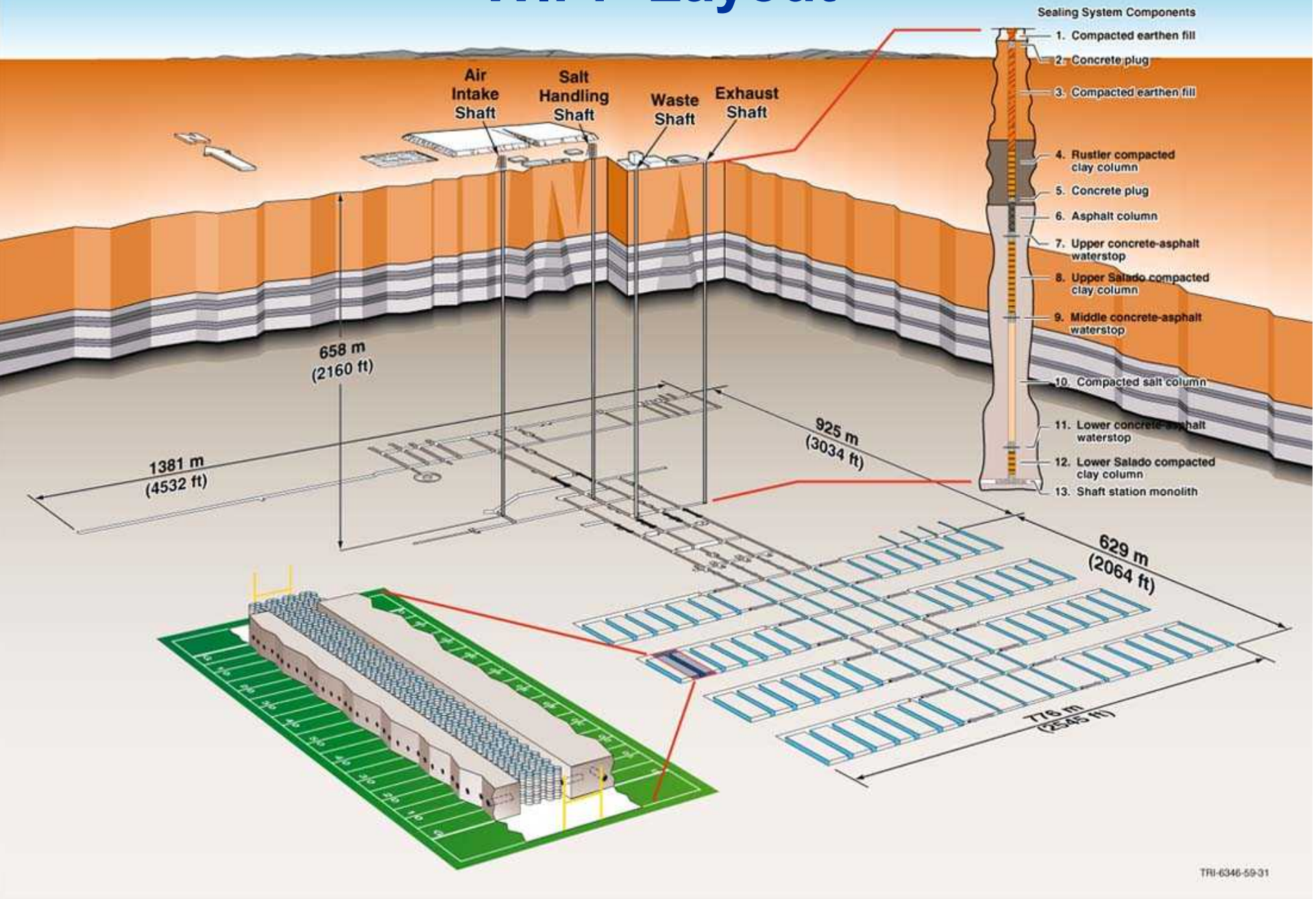
Introduction

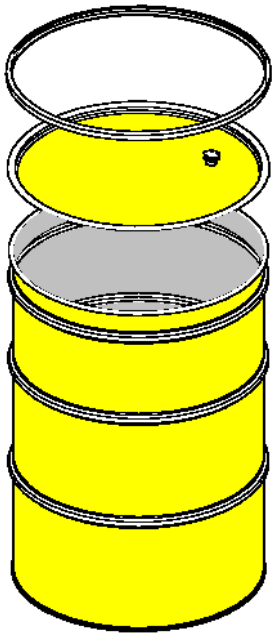
- This paper develops a series of room closure and porosity surface calculations, which are used to assess performance of the Waste Isolation Pilot Plant (WIPP).
- The concept of a porosity surface comprises calculation of room closure as salt creep is resisted by back stress created by the waste packages and by hypothetical gas generation within the rooms.
- These analyses provide insight into the structural response of a room full of various wastes, including the influence of the waste on room closure in the absence of gas generation, as well as the lack of waste influence when gas generation is modeled.
- All of the underlying assumptions pertaining to the original compliance certification including use of the same finite element code are implemented; only the material parameters describing the more robust waste packages are changed.


Location of WIPP
New Mexico
WIPP
New Mexico
N
WIPP
Carlsbad
Delaware Basin
Lake Avalon
360
180
62
WIPP Boundary
Carlsbad
Pecos River
31
285
128
Loving
Salt Lakes
Malaga
Eddy County
Lea County
0 5 10 15 mi
0 10 20 km
2883-1

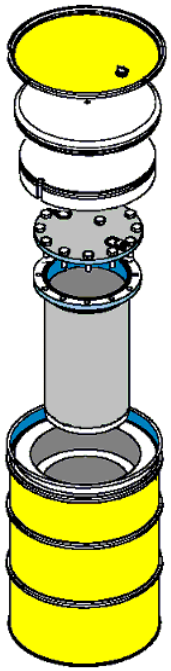
WIPP Layout


Air Intake Shaft
Salt Handling Shaft
Waste Shaft
Exhaust Shaft
658 m (2160 ft)
1381 m (4532 ft)
925 m (3034 ft)
629 m (2064 ft)
776 m (2545 ft)
Sealing System Components
1. Compacted earthen fill
2. Concrete plug
3. Compacted earthen fill
4. Rustler compacted clay column
5. Concrete plug
6. Asphalt column
7. Upper concrete-asphalt waterstop
8. Upper Salado compacted clay column
9. Middle concrete-asphalt waterstop
10. Compacted salt column
11. Lower concrete-asphalt waterstop
12. Lower Salado compacted clay column
13. Shaft station monolith
TRI-6346-59-31

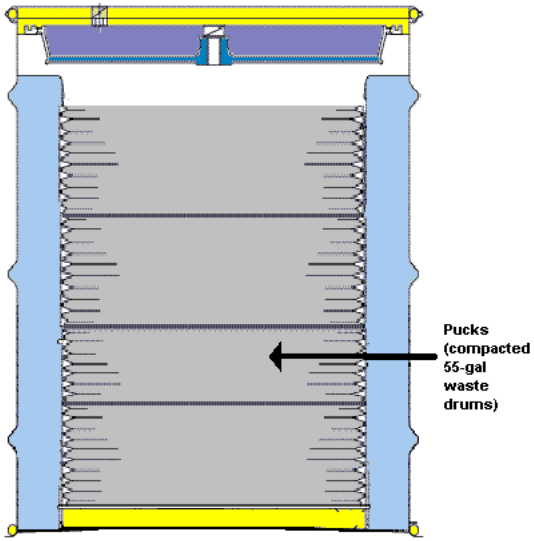
Various Waste Packages



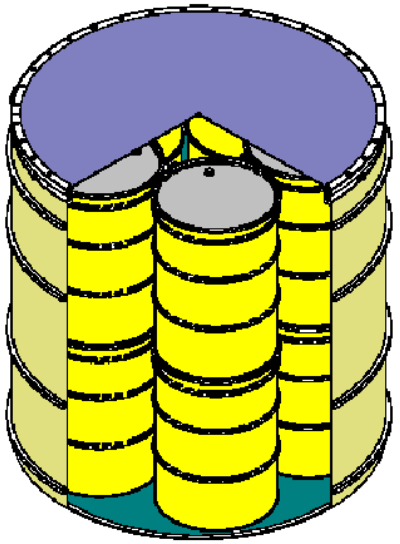
Standard
55-Gallon Drum



Pipe Overpack within
a 55-Gallon Drum

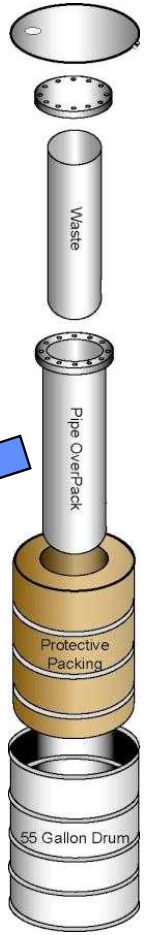


AMW Compressed Pucks
in 100-Gallon Drum



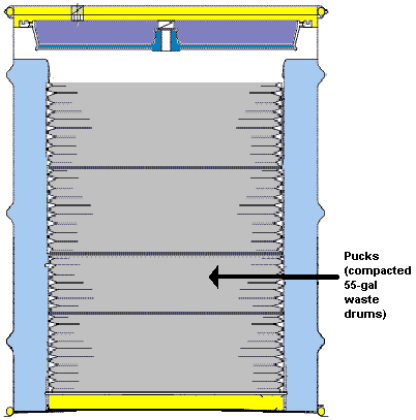
Ten Drum Overpack
(TDOP)

Pipe Overpack

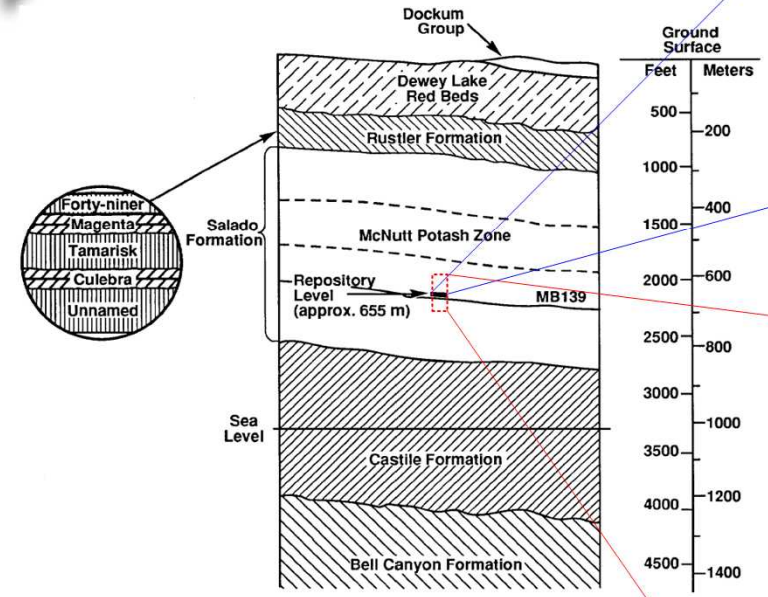


- This waste package is called a pipe overpack (POP) because inside the standard 55-gallon drum is a stainless steel pipe containing the waste.
- This package has been shown to be much more rigid than the standard waste package.

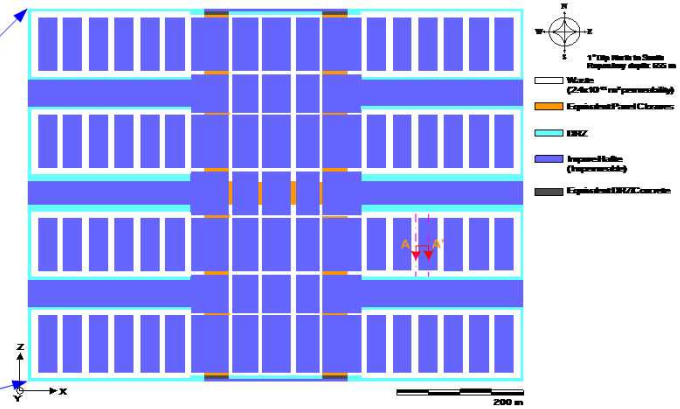
AMW (Advanced Mixed Waste)



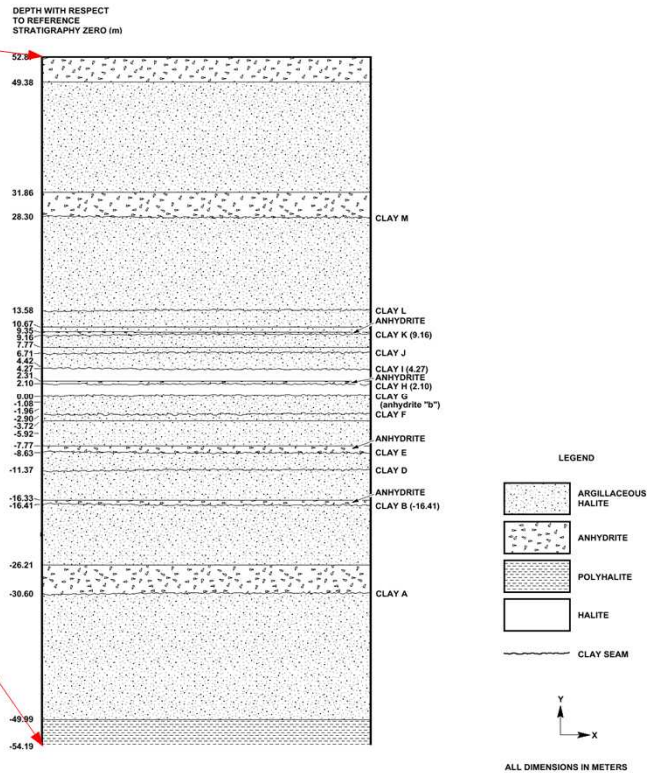
- AMW includes highly compressed 55-gal drums of waste, which are placed in a 100-gal drum.
- Super-compaction process applies 60 MPa to compress the initial 55-gal drums into the so-called “pucks”.
- The maximum *in situ* stress at WIPP is 15 MPa, so the pucks will not be further deformed by salt compaction.



Generalized WIPP stratigraphy

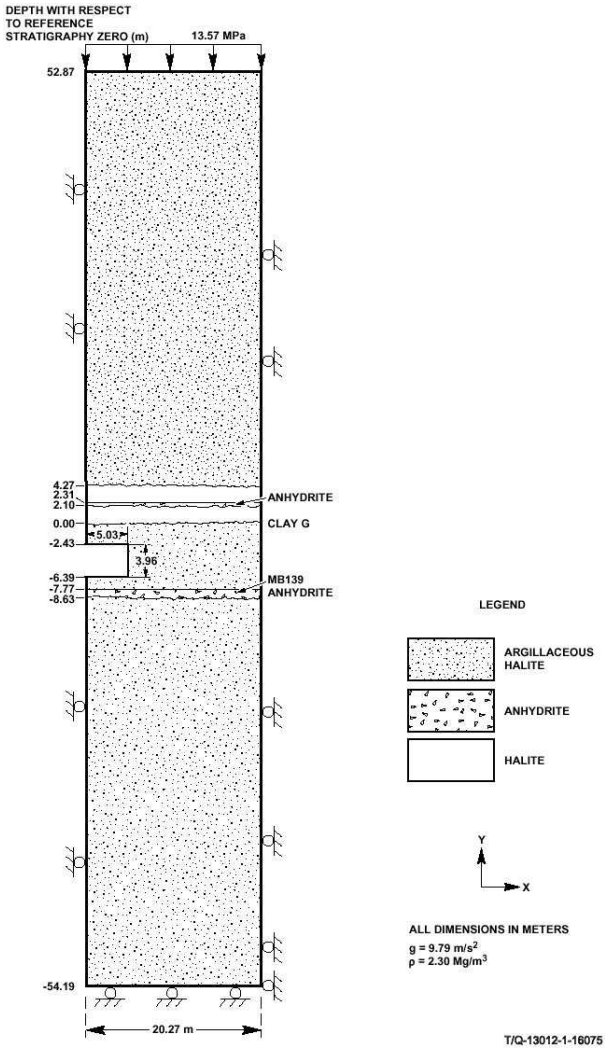


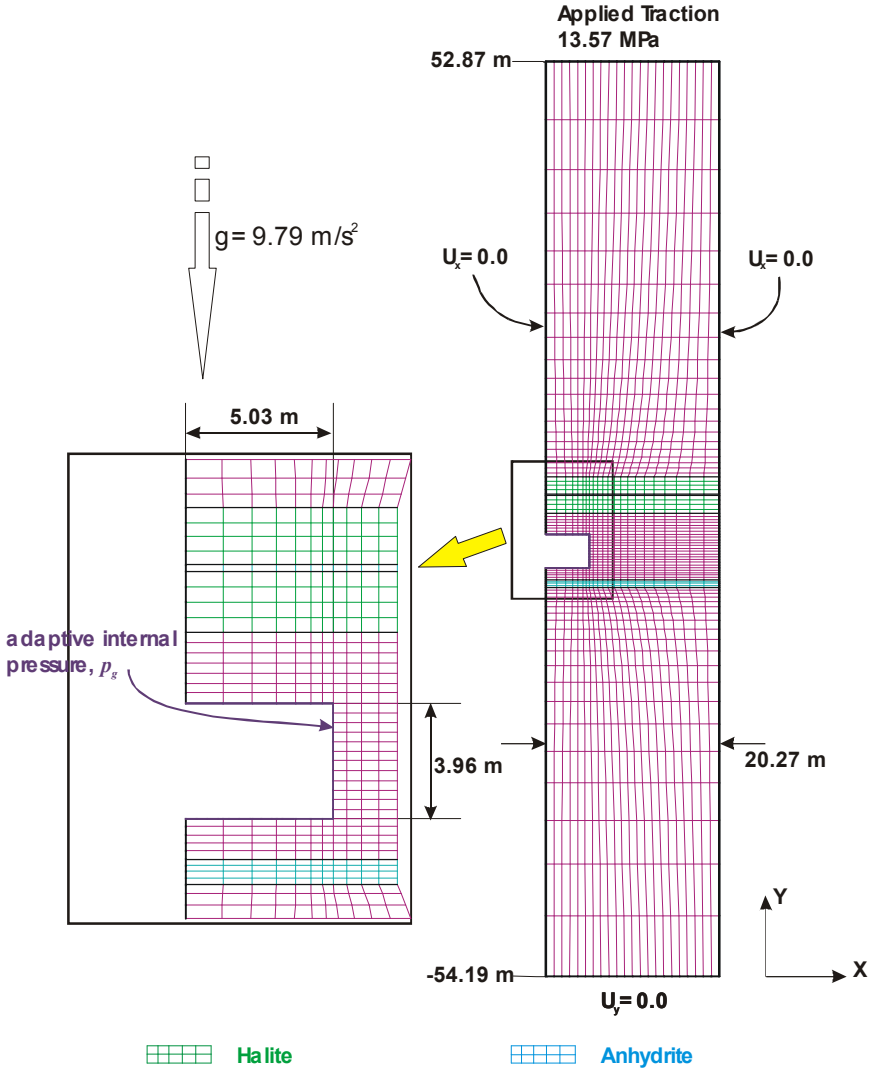
Layout of Disposal Rooms



Idealized Stratigraphy Near the Disposal Room Horizon Defined by Munson et al. (1989).

Simplified Stratigraphic Model, Mesh, and Boundary Conditions

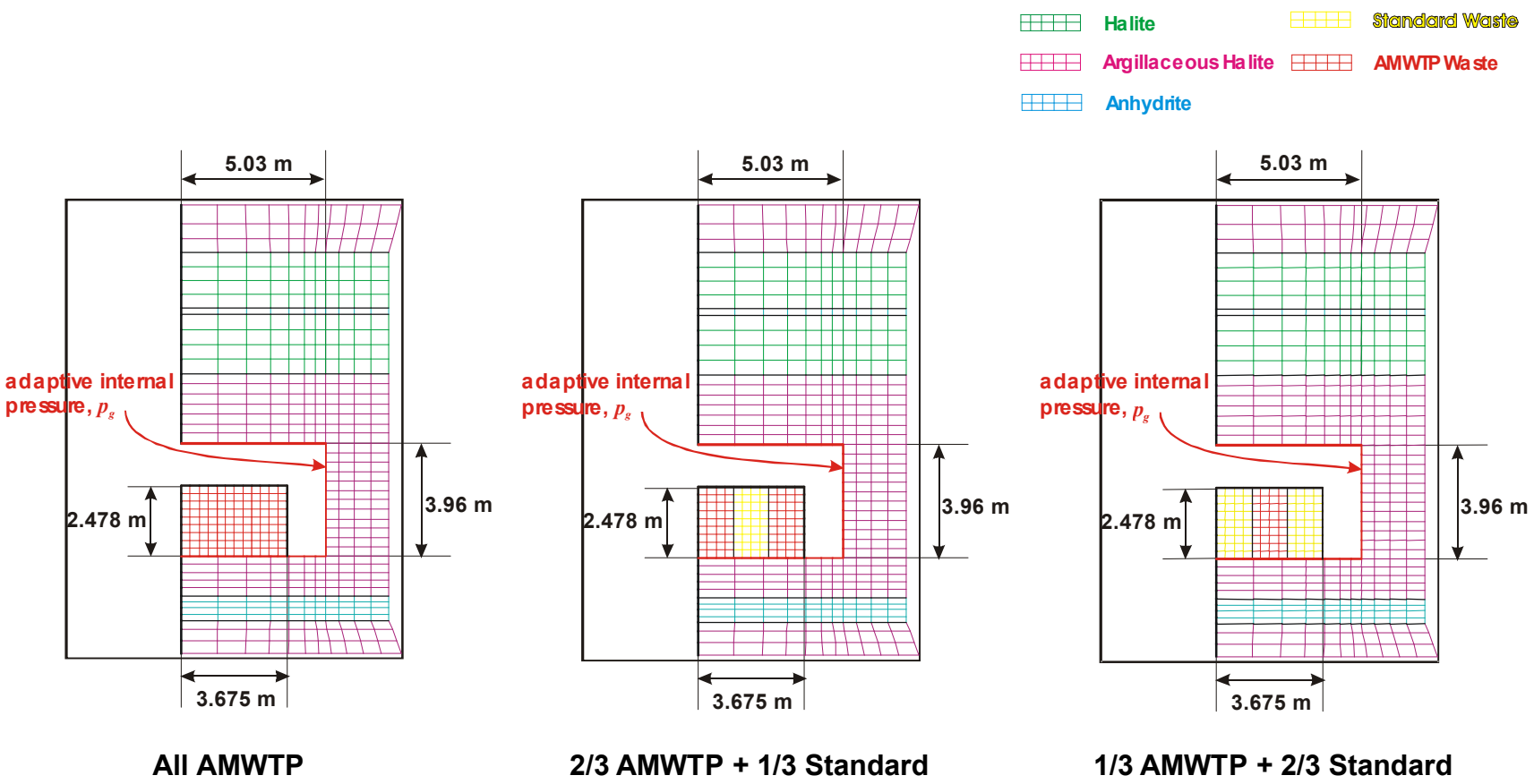




Possible Waste Room Inventories

- To account for the uncertainty in future placement of waste packages, six combinations are considered.
  1. All standard waste (55-gal drums)
  2. All 6-inch POPs
  3. All 12-inch POPs
  4. A mix of 1/3 AMW and 2/3 standard waste
  5. A mix of 2/3 AMW and 1/3 standard waste
  6. All AMW waste packages
- Rigidity and porosity
  - Standard drums have high porosity and low rigidity
  - POPs have high porosity and high rigidity
  - AMW packages have low porosity and high rigidity

Meshes for Various Waste Package Inventories in the Disposal Room



All AMWTP

2/3 AMWTP + 1/3 Standard

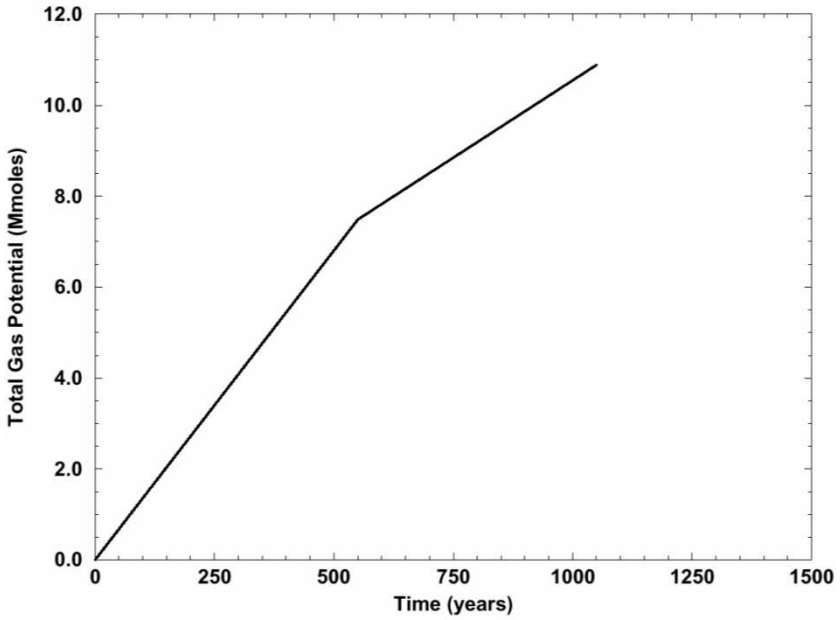
1/3 AMWTP + 2/3 Standard

Gas Generation Potential for Standard Waste

- The gas generation potential and gas production rate are composed of gas from two sources: anoxic corrosion and microbial activity.
- The gas pressure in the disposal room was computed from the ideal gas law based on the current free volume of the room:

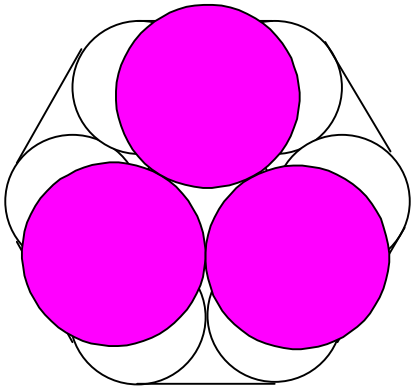
$$p_g = f \cdot \frac{NRT}{V} \qquad (4)$$

N = mass of gas in g-moles
R = universal gas constant
T = absolute temperature (300 ºK)
V = free room volume
f = gas generation factor

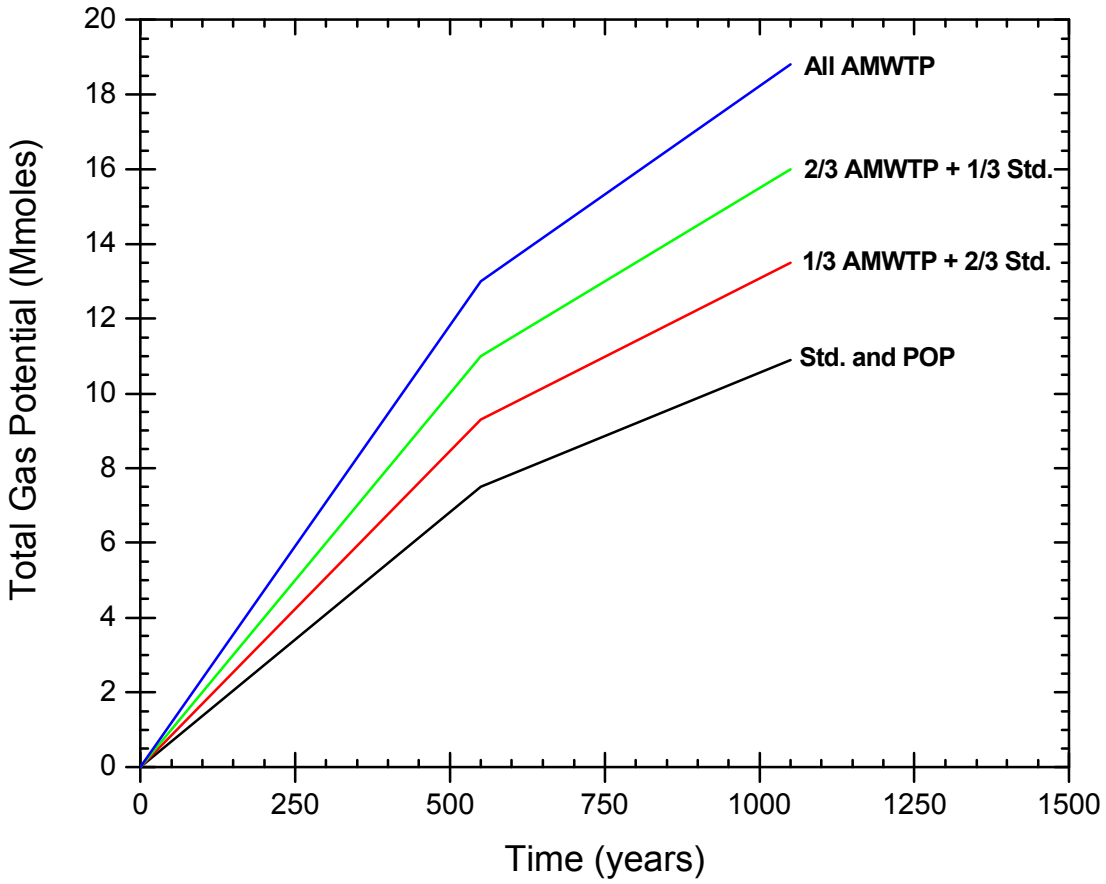


History of the reference gas generation potential Used for the disposal room analysis, f = 1.0

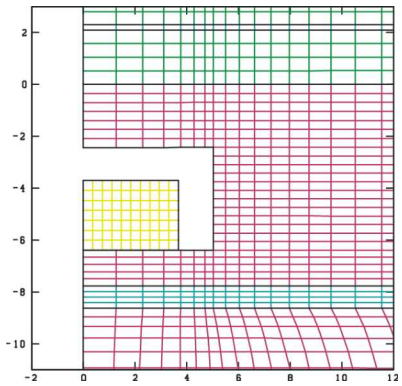
Gas Generation Potential for Each Waste Combination

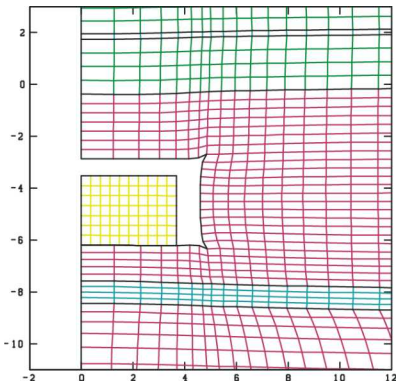


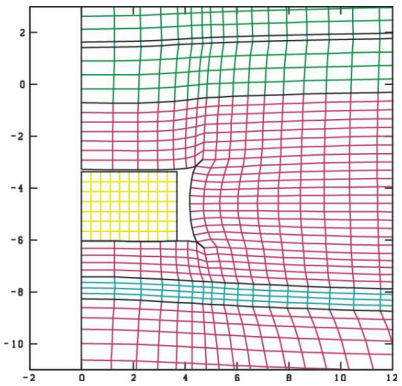
Footprints of three-pack of 100-gal containers and seven-pack of 55-gal drums

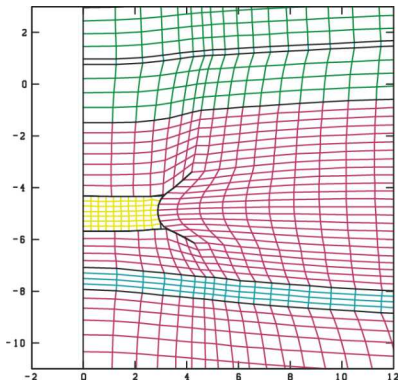


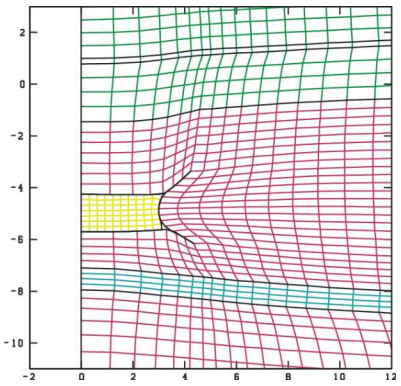
Disposal Room Creep Closure, *f* = 0.0 (Standard Waste)

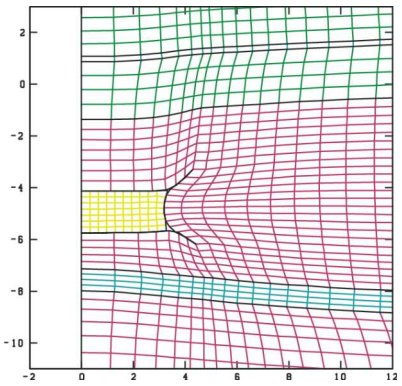

0 year


8 years


25 years


10,000 years


1,000 years


300 years

Argillaceous Halite

Clean Halite

Anhydrite

Waste

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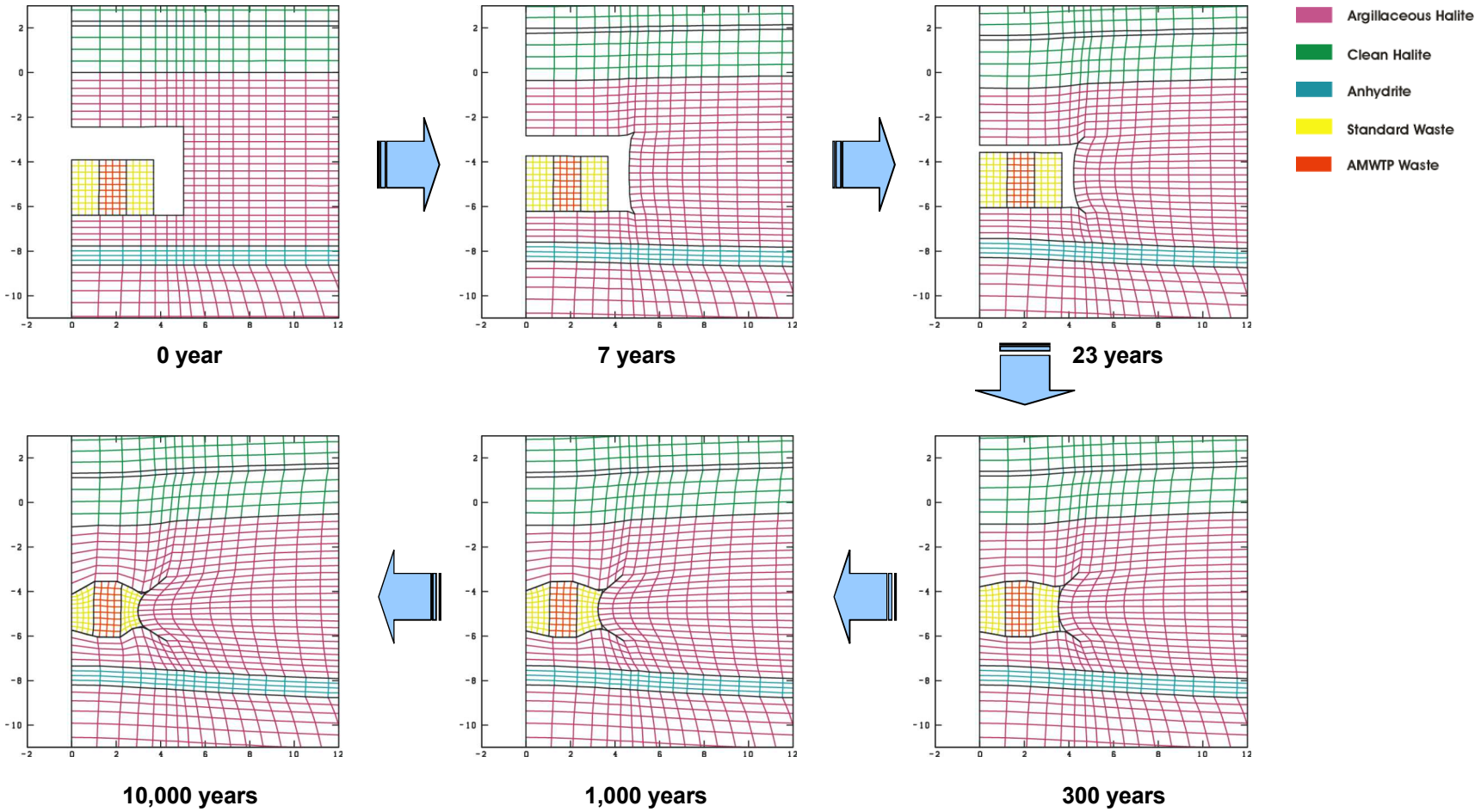
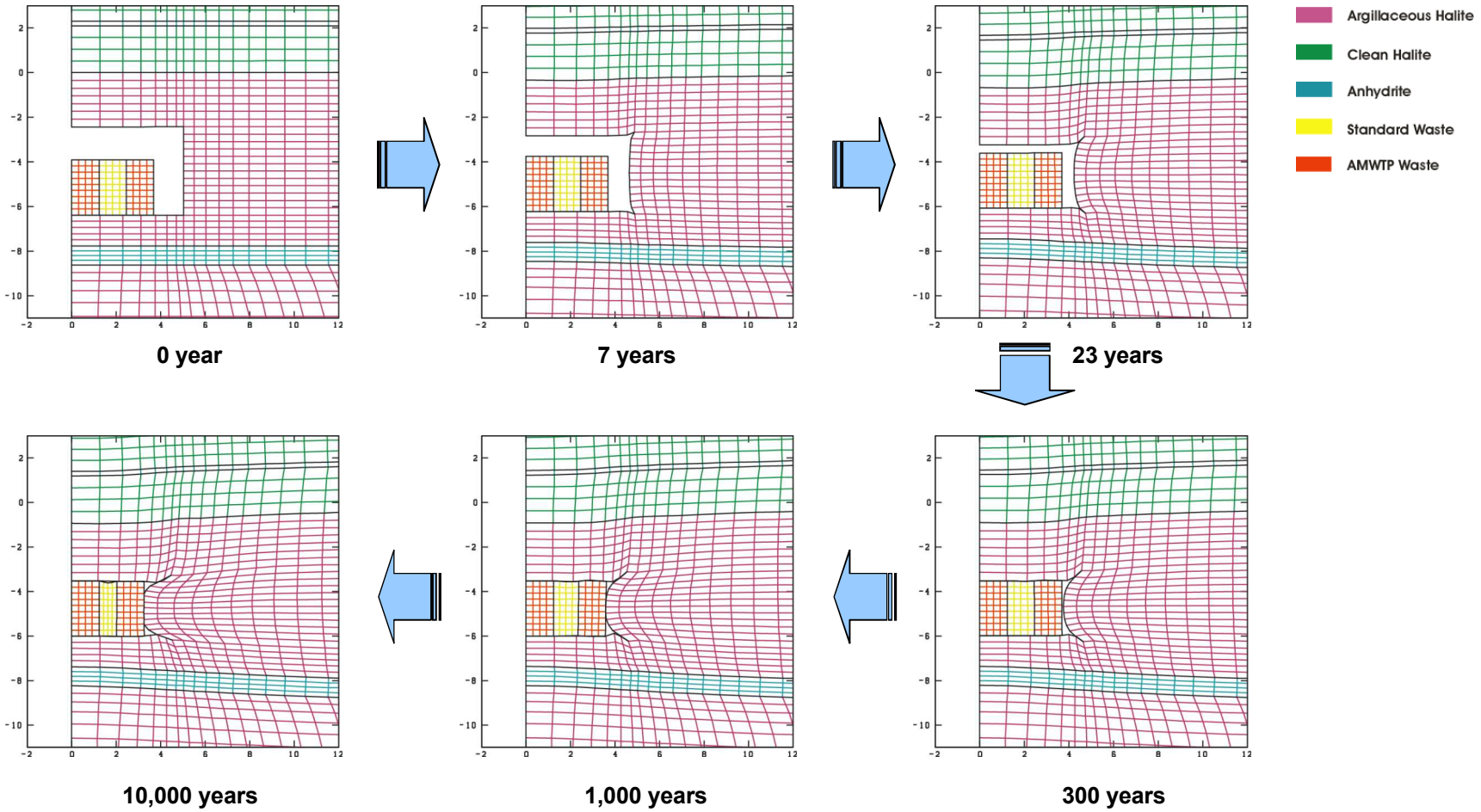
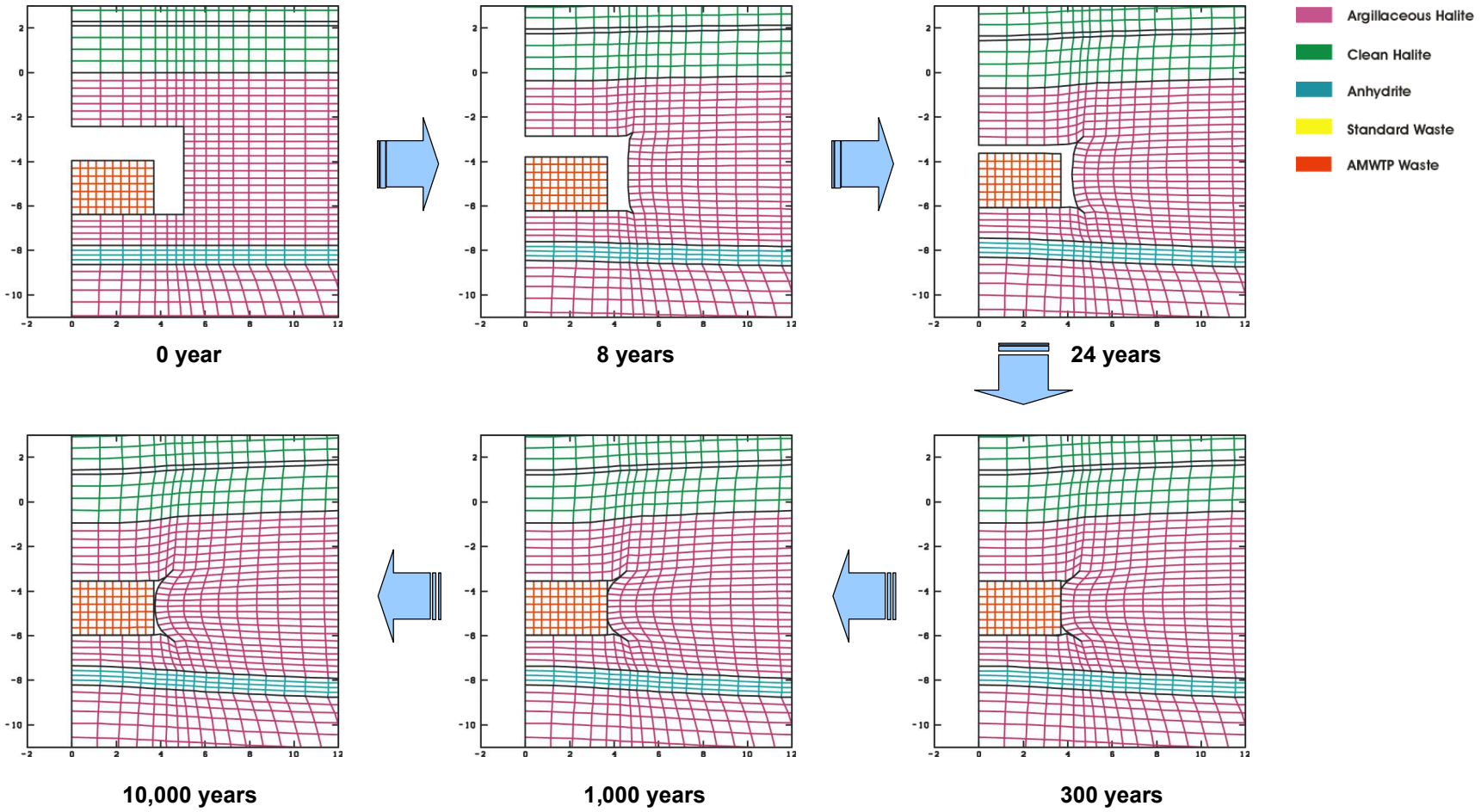
Disposal Room Creep Closure, *f* = 0.0 (1/3 AMW + 2/3 Standard Waste)



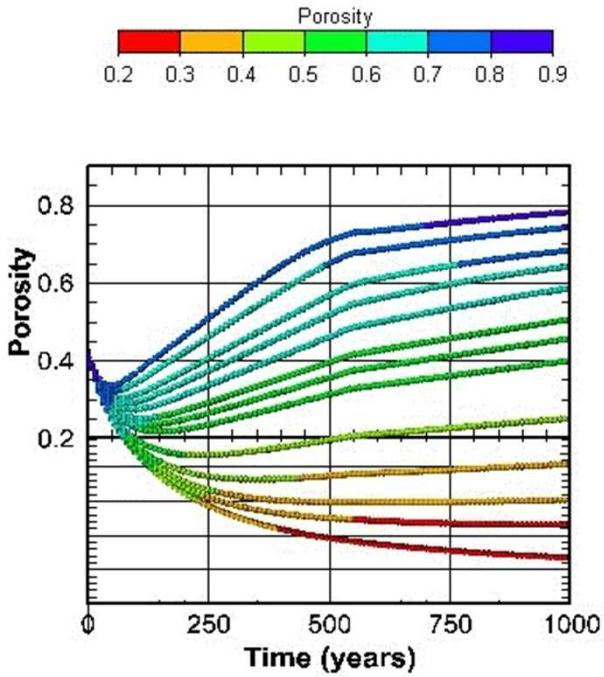
Disposal Room Creep Closure, *f* = 0.0 (2/3 AMW + 1/3 Standard Waste)



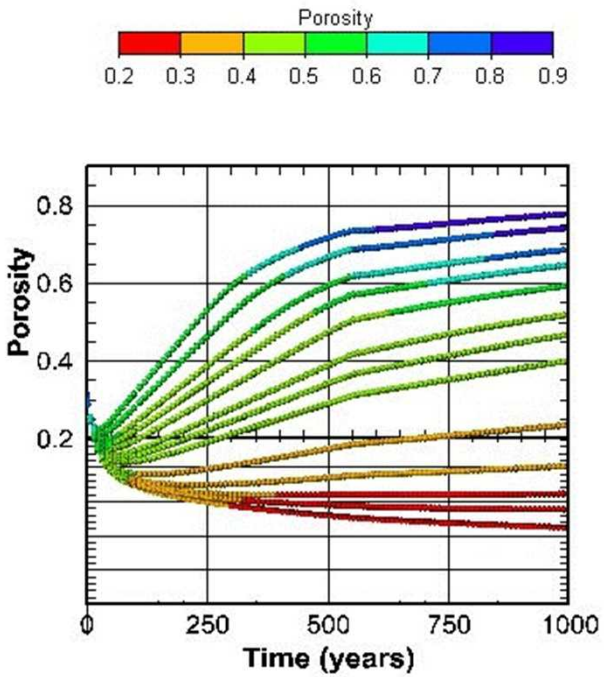
Disposal Room Creep Closure, *f* = 0.0 (All AMW)



Porosity Surfaces for Rooms Containing Standard Waste and All AMW Waste

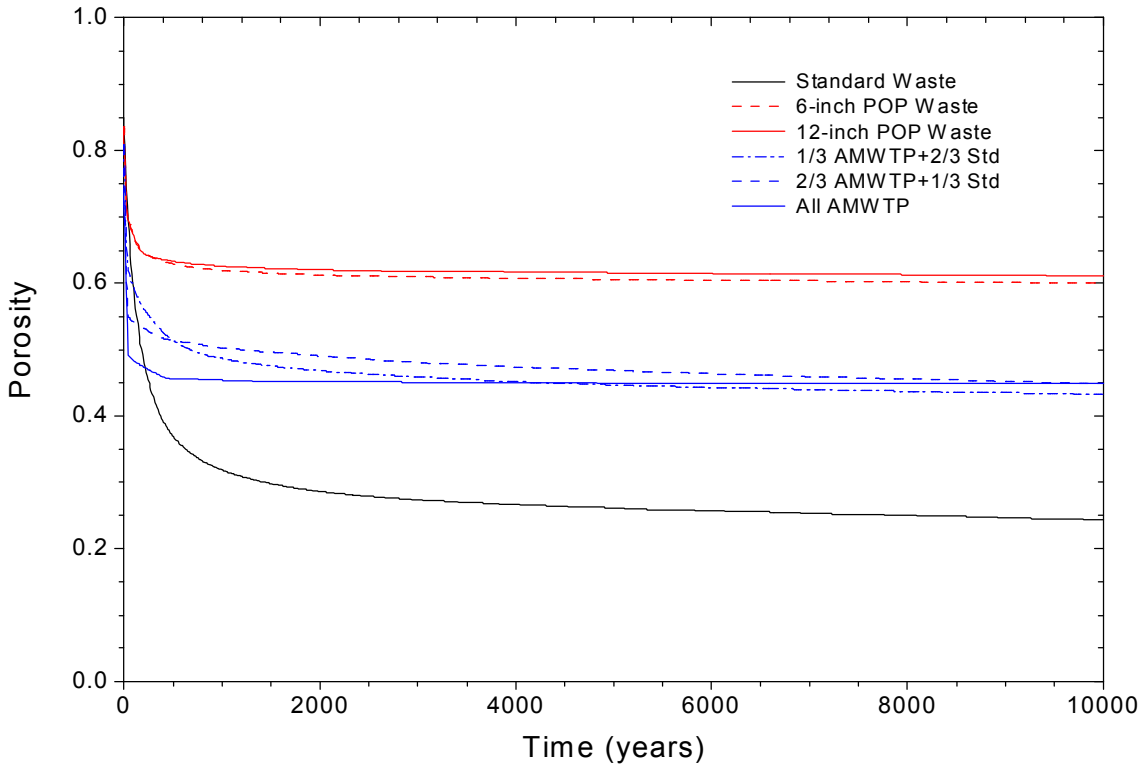


Standard Waste

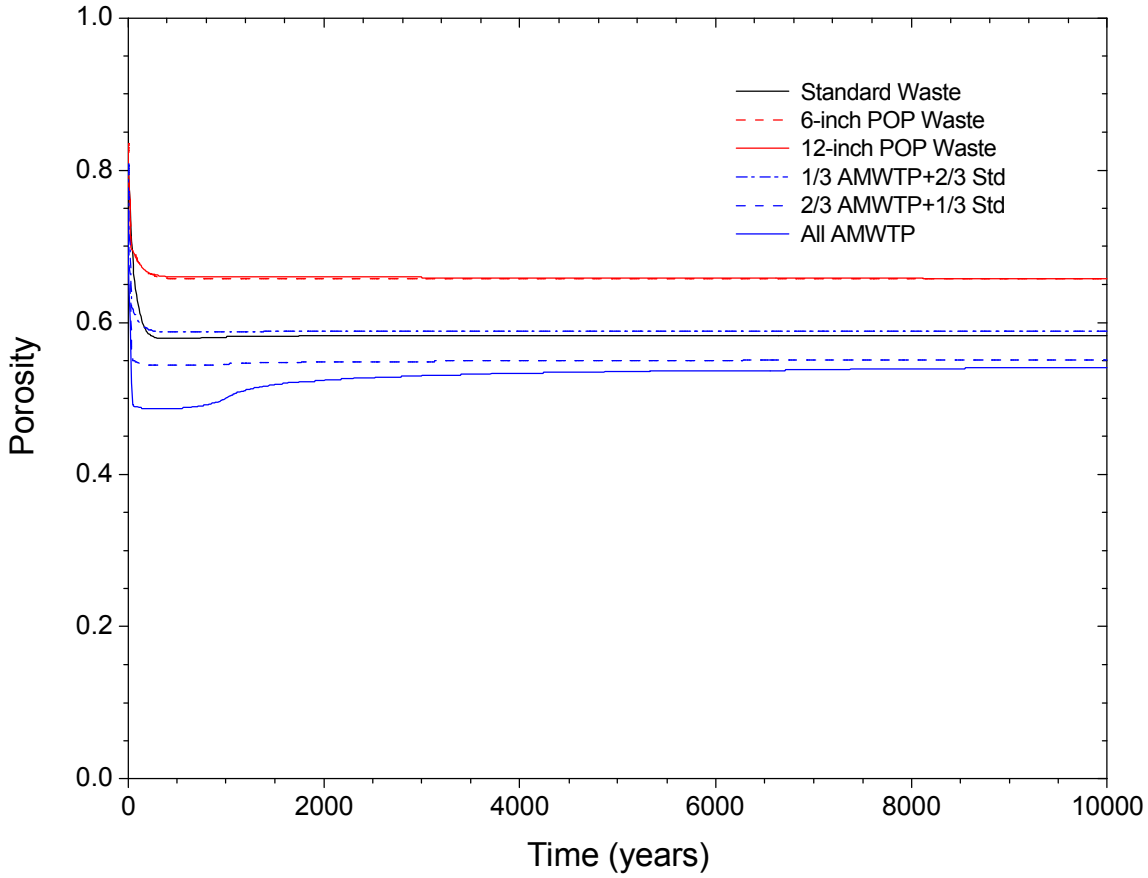


All AMWTP Waste

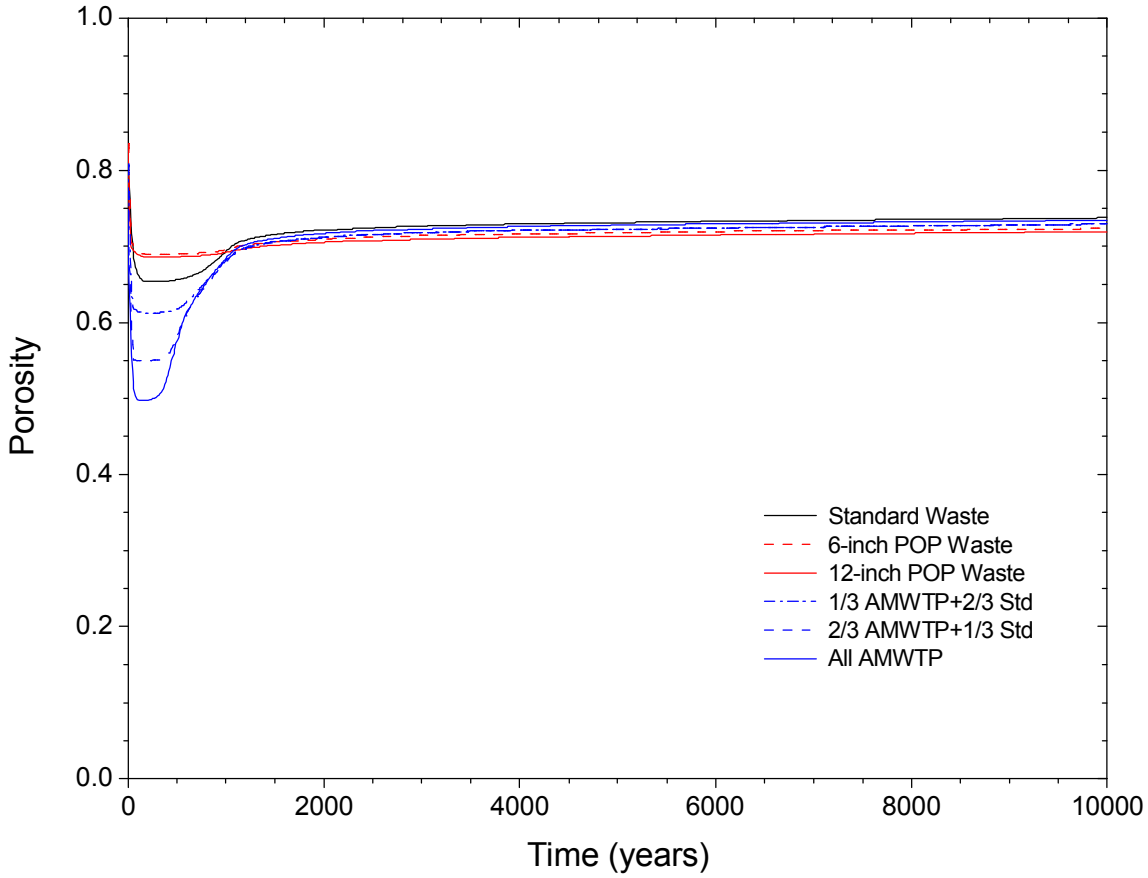
Porosity Histories for Disposal Rooms Containing Various Waste Inventories, *f* = 0.0



Porosity Histories for Disposal Rooms Containing Various Waste Inventories, *f* = 0.4



Porosity Histories for Disposal Rooms Containing Various Waste Inventories, *f* = 1.0



Conclusions

- The primary purpose of these analyses is to assess the structural/mechanical impact to room closure and porosity development resulting from various waste packages.
- The AMW wastes generate more gas than the standard waste and the more rigid waste packages tend to hold the room open and preserve porosity.
- The combination of these effects gives rise to porosity surfaces that differ from the original certification calculation, particularly for the future states in which no gas is generated.
- No gas generation case is little potential for release so the overall effect on performance is not important.

Acknowledgement

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